

WHAT IS CLAIMED IS:

1. A crosslinked rubber particle comprising as repeating units (a) 30 to 94.89 % by weight of a conjugated diene unit, (b) 5 to 69.89 % by weight of an aromatic vinyl unit, (c) 0.01 to 10 % by weight of a monomer unit having at least two polymerizable unsaturated group and (d) 0.1 to 30 % by weight of a monomer unit having one polymerizable unsaturated group and at least one functional group selected from an amino group, a hydroxyl group and an epoxy group [the total amount of (a), (b), (c) and (d) is 100 % by weight] and having a particle size of 10 to 500 nm and a toluene-insolubles of 80 % by weight or more.

2. A crosslinked rubber particle according to Claim 1, wherein

said monomer forming said monomer unit (d) having one polymerizable unsaturated group and an amino group is at least one selected from dialkylaminoalkyl (meth)acrylates, N-dialkylaminoalkyl group-containing unsaturated amides, dialkylaminoalkyl (meth)acrylate and tertiary amino group-containing vinyl aromatic compound.

3. A crosslinked rubber particle according to Claim 1, wherein

said monomer forming said monomer unit (d) having one polymerizable unsaturated group and a hydroxyl group is at least one selected from hydroxyalkyl (meth)acrylates, mono

(meth)acrylates of polyalkylene glycols (the number of alkylene glycol units is 2 to 23), hydroxyl group-containing unsaturated amides, hydroxyl group-containing vinyl aromatic compounds and (meth)allyl alcohol.

4. A crosslinked rubber particle according to Claim 1, wherein

said monomer forming said monomer unit (d) having one polymerizable unsaturated group and an epoxy group is at least one selected from (meth)allylglycidylether, glycidyl (meth)acrylate and 3,4-oxycyclohexyl (meth)acrylate.

5. A crosslinked rubber particle according to Claim 1, wherein

said conjugated diene forming said conjugated diene unit (a) is at least one selected from 1,3-butadiene, 2,3-dimethyl-1,3-butadiene, isoprene and chloroprene;

said aromatic vinyl forming said aromatic vinyl unit (b) is at least one selected from styrene, 2-methylstyrene, 3-methylstyrene, 4-methylstyrene, α -methylstyrene, 2,4-dimethylstyrene, 2,4-diisopropylstyrene, 4-tert-butylstyrene and tert-butoxystyrene; and,

said monomer forming said monomer unit (c) having at least two polymerizable unsaturated groups is at least one selected from ethylene glycol di(meth)acrylate, propylene glycol di(meth)acrylate, 1,4-butanediol

di(meth)acrylate, 1,6-hexanediol di(meth)acrylate, trimethylolpropane di(meth)acrylate, trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, divinylbenzene, diisopropenylbenzene and trivinylbenzene.

6. A crosslinked rubber particle according to Claim 5, wherein

said monomer forming said monomer unit (d) having one polymerizable unsaturated group and an amino group is at least one selected from dialkylaminoalkyl (meth)acrylates, N-dialkylaminoalkyl group-containing unsaturated amides, dialkylaminoalkyl (meth)acrylate and tertiary amino group-containing vinyl aromatic compound.

7. A crosslinked rubber particle according to Claim 5, wherein

said monomer forming said monomer unit (d) having one polymerizable unsaturated group and a hydroxyl group is at least one selected from hydroxyalkyl (meth)acrylates, mono (meth)acrylates of polyalkylene glycols (the number of alkylene glycol units is 2 to 23), hydroxyl group-containing unsaturated amides, hydroxyl group-containing vinyl aromatic compounds and (meth)allyl alcohol.

8. A crosslinked rubber particle according to Claim 5, wherein

said monomer forming said monomer unit (d) having one

polymerizable unsaturated group and an epoxy group is at least one selected from (meth)allylglycidylether, glycidyl (meth)acrylate and 3,4-oxycyclohexyl (meth)acrylate.

9. A rubber composition comprising:

[1] at least one crosslinked rubber particle selected from:

(1) a crosslinked rubber particle comprising as repeating units (a) 30 to 94.89 % by weight of a conjugated diene unit, (b) 5 to 69.89 % by weight of an aromatic vinyl unit, (c) 0.01 to 10 % by weight of a monomer unit having at least two polymerizable unsaturated group and (d) 0.1 to 30 % by weight of a monomer unit having one polymerizable unsaturated group and at least one functional group selected from an amino group, a hydroxyl group and an epoxy group [the total amount of (a), (b), (c) and (d) is 100 % by weight] and having a particle size of 10 to 500 nm and a toluene-insolubles of 80 % by weight or more;

(2) a crosslinked rubber particle comprising as repeating units (a) 30 to 94.89 % by weight of a conjugated diene unit, (b) 5 to 69.89 % by weight of an aromatic vinyl unit, (c) 0.01 to 10 % by weight of a monomer unit having at least two polymerizable unsaturated group and (e) 0.1 to 30 % by weight of a monomer unit having one polymerizable unsaturated group and a carboxylic group (CO_2H and/or CO_2^-)

[the total amount of (a), (b), (c) and (e) is 100 % by weight] and having a particle size of 10 to 500 nm and a toluene-insolubles of 80 % by weight or more; and,

(3) a crosslinked rubber particle comprising as repeating units (a) 30 to 94.99 % by weight of a conjugated diene unit, (b) 5 to 69.99 % by weight of an aromatic vinyl unit and (c) 0.01 to 10 % by weight of a monomer unit having at least two polymerizable unsaturated group [the total amount of (a), (b) and (c) is 100 % by weight] and having a particle size of 10 to 500 nm and a toluene-insolubles of 80 % by weight or more; and,

[2] a non-crosslinked rubber component whose toluene-insolubles is less than 20 % by weight,

wherein said non-crosslinked rubber component is at least one selected from (A) a polymer consisting of as a repeating unit only a conjugated diene unit, (B) a polymer which comprises as repeating units a conjugated diene unit and an aromatic vinyl unit and whose conjugated diene unit has a 1,4-trans content of 55 % or less, (C) a polymer comprising as repeating units a conjugated diene unit and an α,β -unsaturated nitrile unit, (D) an acrylic rubber and (E) a polymer comprising as repeating units an ethylene unit and an α -olefin unit having 3 to 12 carbon atoms.

10. A rubber composition according to Claim 9, wherein said conjugated diene forming said conjugated diene

unit (a) is at least one selected from 1,3-butadiene, 2,3-dimethyl-1,3-butadiene, isoprene and chloroprene;

said aromatic vinyl forming said aromatic vinyl unit (b) is at least one selected from styrene, 2-methylstyrene, 3-methylstyrene, 4-methylstyrene, α -methylstyrene, 2,4-dimethylstyrene, 2,4-diisopropylstyrene, 4-tert-butylstyrene and tert-butoxystyrene; and,

said monomer forming said monomer unit (c) having at least two polymerizable unsaturated groups is at least one selected from ethylene glycol di(meth)acrylate, propylene glycol di(meth)acrylate, 1,4-butanediol di(meth)acrylate, 1,6-hexanediol di(meth)acrylate, trimethylolpropane di(meth)acrylate, trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, divinylbenzene, diisopropenylbenzene and trivinylbenzene.

11. A rubber composition according to Claim 10, wherein

said monomer forming said monomer unit (d) having one polymerizable unsaturated group and an amino group is at least one selected from dialkylaminoalkyl (meth)acrylates, N-dialkylaminoalkyl group-containing unsaturated amides and tertiary amino group-containing vinyl aromatic compound.

12. A rubber composition according to Claim 10, wherein

said monomer forming said monomer unit (d) having one

polymerizable unsaturated group and a hydroxyl group is at least one selected from hydroxyalkyl(meth)acrylates, mono(meth)acrylates of a polyalkylene glycol (the number of alkylene glycol units is for example 2 to 23), hydroxyl group-containing unsaturated amides, hydroxyl group-containing unsaturated vinyl aromatic compounds and (meth)allyl alcohol.

13. A rubber composition according to Claim 10, wherein said monomer forming said monomer unit (d) having one polymerizable unsaturated group and an epoxy group is at least one selected from (meth)allylglycidylether, glycidyl (meth)acrylate and 3,4-oxycyclohexyl (meth)acrylate.

14. A rubber composition according to Claim 9, wherein said monomer forming said monomer unit (e) having one polymerizable unsaturated group and a carboxylic group (CO_2H and/or CO_2^-) is at least one selected from unsaturated carboxylic acids, free carboxyl group-containing esters and their salts.

15. A rubber composition according to Claim 9, further comprising at least one selected from a silica and a carbon black.

16. A rubber composition according to Claim 15, wherein said conjugated diene forming said conjugated diene unit (a) is at least one selected from 1,3-butadiene,

2,3-dimethyl-1,3-butadiene, isoprene and chloroprene;

said aromatic vinyl forming said aromatic vinyl unit (b) is at least one selected from styrene, 2-methylstyrene, 3-methylstyrene, 4-methylstyrene, α -methylstyrene, 2,4-dimethylstyrene, 2,4-diisopropylstyrene, 4-tert-butylstyrene and tert-butoxystyrene; and,

said monomer forming said monomer unit (c) having at least two polymerizable unsaturated groups is at least one selected from ethylene glycol di(meth)acrylate, propylene glycol di(meth)acrylate, 1,4-butanediol di(meth)acrylate, 1,6-hexanediol di(meth)acrylate, trimethylolpropane di(meth)acrylate, trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, divinylbenzene, diisopropenylbenzene and trivinylbenzene.

17. A rubber composition according to Claims 16, wherein

said monomer forming said monomer unit (e) having one polymerizable unsaturated group and a carboxylic group (CO_2H and/or CO_2^-) is at least one selected from unsaturated carboxylic acids, free carboxyl group-containing esters and their salts.

18. A rubber composition according to Claim 15, further comprising a silane coupling agent.